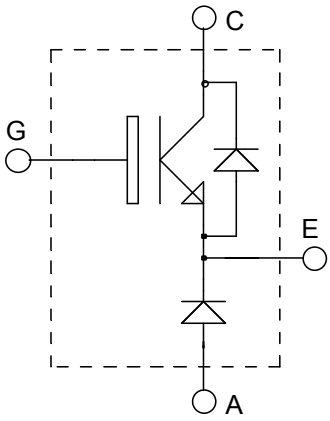
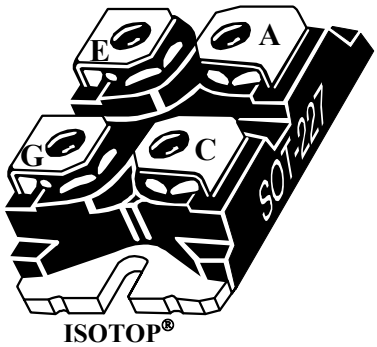
# APT50GF60JU3

## *ISOTOP® Buck chopper NPT IGBT*

**$V_{CES}$ = 600V**
**$I_C$ = 50A @ Tc = 90°C**




ISOTOP®

**Application**

- AC and DC motor control
- Switched Mode Power Supplies

**Features**

- Non Punch Through (NPT) THUNDERBOLT IGBT
  - Low voltage drop
  - Low tail current
  - Switching frequency up to 100 kHz
  - Soft recovery parallel diodes
  - Low diode VF
  - Low leakage current
  - RBSOA and SCSOA rated
- ISOTOP® Package (SOT-227)
- Very low stray inductance
- High level of integration

**Benefits**

- Outstanding performance at high frequency operation
- Stable temperature behavior
- Very rugged
- Direct mounting to heatsink (isolated package)
- Low junction to case thermal resistance
- Easy paralleling due to positive $T_C$ of $V_{CEsat}$
- RoHS Compliant

## Absolute maximum ratings

| *Symbol* | *Parameter* | | | *Max ratings* | *Unit* |
|---|---|---|---|---|---|
| $V_{CES}$ | Collector - Emitter Breakdown Voltage | | | 600 | V |
| $I_{C1}$ | Continuous Collector Current | | $T_C$ = 25°C | 75 | A |
| $I_{C2}$ | | | $T_C$ = 90°C | 50 | |
| $I_{CM}$ | Pulsed Collector Current | | $T_C$ = 25°C | 160 | |
| $V_{GE}$ | Gate – Emitter Voltage | | | ±20 | V |
| $P_D$ | Maximum Power Dissipation | | $T_C$ = 25°C | 277 | W |
| $I_{LM}$ | RBSOA clamped Inductive load Current $R_G$=11Ω | | $T_C$ = 25°C | 100 | A |
| $IF_{AV}$ | Maximum Average Forward Current | Duty cycle=0.5 | $T_C$ = 80°C | 30 | A |
| $IF_{RMS}$ | RMS Forward Current (Square wave, 50% duty) | | | 39 | |

**CAUTION:** These Devices are sensitive to Electrostatic Discharge. Proper Handling Procedures Should Be Followed.

**All ratings @ $T_j$ = 25°C unless otherwise specified**

## Electrical Characteristics

| *Symbol* | *Characteristic* | *Test Conditions* | | *Min* | *Typ* | *Max* | *Unit* |
|---|---|---|---|---|---|---|---|
| $I_{CES}$ | Zero Gate Voltage Collector Current | $V_{GE}$ = 0V, $V_{CE}$ = 600V | $T_j$ = 25°C | | | 40 | µA |
| | | | $T_j$ = 125°C | | | 1000 | |
| $V_{CE(sat)}$ | Collector Emitter saturation Voltage | $V_{GE}$ =15V, $I_C$ = 50A | $T_j$ = 25°C | | 2.1 | 2.7 | V |
| | | | $T_j$ = 125°C | | 2.2 | 2.8 | |
| $V_{GE(th)}$ | Gate Threshold Voltage | $V_{GE} = V_{CE}$, $I_C$ = 700µA | | 4.5 | 5.5 | 6.5 | V |
| $I_{GES}$ | Gate – Emitter Leakage Current | $V_{GE}$ = ±20V, $V_{CE}$ = 0V | | | | ±100 | nA |

## Dynamic Characteristics

| *Symbol* | *Characteristic* | *Test Conditions* | *Min* | *Typ* | *Max* | *Unit* |
|---|---|---|---|---|---|---|
| $C_{ies}$ | Input Capacitance | $V_{GE}$ = 0V<br>$V_{CE}$ = 25V<br>f = 1MHz | | 2250 | | pF |
| $C_{oes}$ | Output Capacitance | | | 255 | | |
| $C_{res}$ | Reverse Transfer Capacitance | | | 155 | | |
| $Q_g$ | Total gate Charge | $V_{GS}$ = 15V<br>$V_{Bus}$ = 300V<br>$I_C$ = 50A | | 175 | | nC |
| $Q_{ge}$ | Gate – Emitter Charge | | | 18 | | |
| $Q_{gc}$ | Gate – Collector Charge | | | 100 | | |
| $T_{d(on)}$ | Turn-on Delay Time | Resistive Switching (25°C)<br>$V_{GE}$ = 15V<br>$V_{Bus}$ = 300V<br>$I_C$ = 50A<br>$R_G$ = 10Ω | | 29 | | ns |
| $T_r$ | Rise Time | | | 118 | | |
| $T_{d(off)}$ | Turn-off Delay Time | | | 150 | | |
| $T_f$ | Fall Time | | | 190 | | |
| $T_{d(on)}$ | Turn-on Delay Time | Inductive Switching (25°C)<br>$V_{GE}$ = 15V<br>$V_{Bus}$ = 400V<br>$I_C$ = 50A<br>$R_G$ = 10Ω | | 30 | | ns |
| $T_r$ | Rise Time | | | 80 | | |
| $T_{d(off)}$ | Turn-off Delay Time | | | 240 | | |
| $T_f$ | Fall Time | | | 43 | | |
| $E_{ts}$ | Total switching Losses | | | 3.6 | | mJ |
| $T_{d(on)}$ | Turn-on Delay Time | Inductive Switching (150°C)<br>$V_{GE}$ = 15V<br>$V_{Bus}$ = 400V<br>$I_C$ = 50A<br>$R_G$ = 10Ω | | 28 | | ns |
| $T_r$ | Rise Time | | | 75 | | |
| $T_{d(off)}$ | Turn-off Delay Time | | | 265 | | |
| $T_f$ | Fall Time | | | 185 | | |
| $E_{on}$ | Turn-on Switching Energy | | | 1.8 | | mJ |
| $E_{off}$ | Turn-off Switching Energy | | | 2.4 | | |
| $E_{ts}$ | Total switching Losses | | | 4.2 | | |

## Chopper diode ratings and characteristics

| Symbol | Characteristic | Test Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $V_F$ | Diode Forward Voltage | $I_F$ = 30A | | | 1.6 | 1.8 | V |
| | | $I_F$ = 60A | | | 1.9 | | |
| | | $I_F$ = 30A | $T_j$ = 125°C | | 1.4 | | |
| $I_{RM}$ | Maximum Reverse Leakage Current | $V_R$ = 600V | $T_j$ = 25°C | | | 250 | µA |
| | | $V_R$ = 600V | $T_j$ = 125°C | | | 500 | |
| $C_T$ | Junction Capacitance | $V_R$ = 200V | | | 44 | | pF |
| $t_{rr}$ | Reverse Recovery Time | $I_F$=1A,$V_R$=30V di/dt =100A/µs | $T_j$ = 25°C | | 23 | | ns |
| | Reverse Recovery Time | $I_F$ = 30A $V_R$ = 400V di/dt =200A/µs | $T_j$ = 25°C | | 85 | | |
| | | | $T_j$ = 125°C | | 160 | | |
| $I_{RRM}$ | Maximum Reverse Recovery Current | | $T_j$ = 25°C | | 4 | | A |
| | | | $T_j$ = 125°C | | 8 | | |
| $Q_{rr}$ | Reverse Recovery Charge | | $T_j$ = 25°C | | 130 | | nC |
| | | | $T_j$ = 125°C | | 700 | | |
| $t_{rr}$ | Reverse Recovery Time | $I_F$ = 30A $V_R$ = 400V di/dt =1000A/µs | $T_j$ = 125°C | | 70 | | ns |
| $Q_{rr}$ | Reverse Recovery Charge | | | | 1300 | | nC |
| $I_{RRM}$ | Maximum Reverse Recovery Current | | | | 30 | | A |

## Thermal and package characteristics

| Symbol | Characteristic | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $R_{thJC}$ | Junction to Case Thermal Resistance | IGBT | | | 0.45 | °C/W |
| | | Diode | | | 1.21 | |
| $R_{thJA}$ | Junction to Ambient (IGBT & Diode) | | | | 20 | |
| $V_{ISOL}$ | RMS Isolation Voltage, any terminal to case t =1 min, 50/60Hz | | 2500 | | | V |
| $T_J$,$T_{STG}$ | Storage Temperature Range | | -55 | | 150 | °C |
| $T_L$ | Max Lead Temp for Soldering:0.063" from case for 10 sec | | | | 300 | |
| Torque | Mounting torque (Mounting = 8-32 or 4mm Machine and terminals = 4mm Machine) | | | | 1.5 | N.m |
| Wt | Package Weight | | | 29.2 | | g |

## Typical IGBT Performance Curve

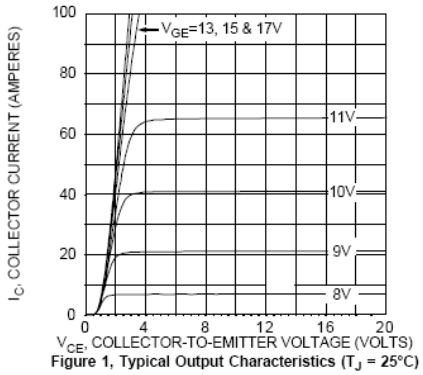



Figure 1, Typical Output Characteristics ($T_J$ = 25°C)

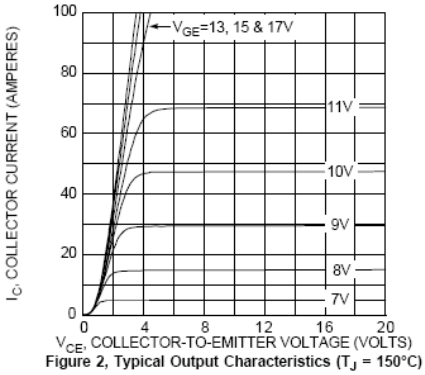



Figure 2, Typical Output Characteristics ($T_J$ = 150°C)

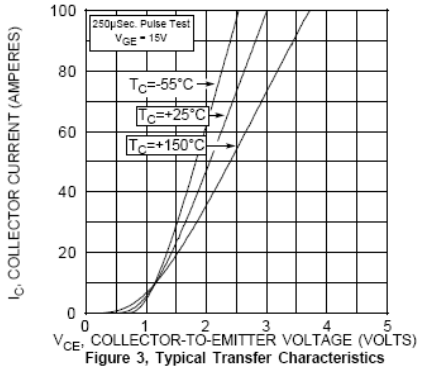



Figure 3, Typical Transfer Characteristics

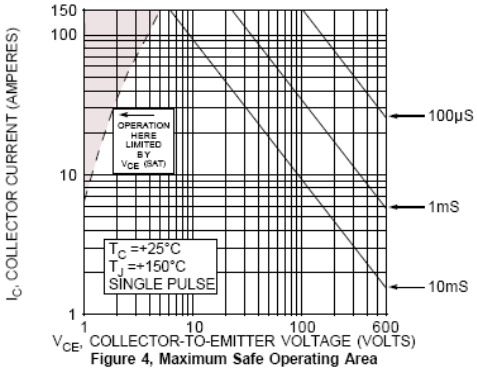



Figure 4, Maximum Safe Operating Area

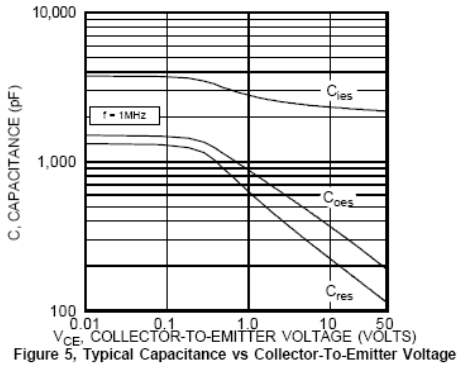



Figure 5, Typical Capacitance vs Collector-To-Emitter Voltage

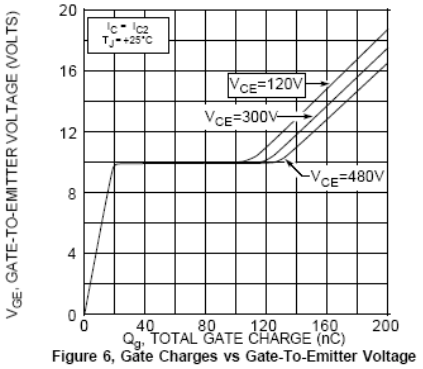



Figure 6, Gate Charges vs Gate-To-Emitter Voltage

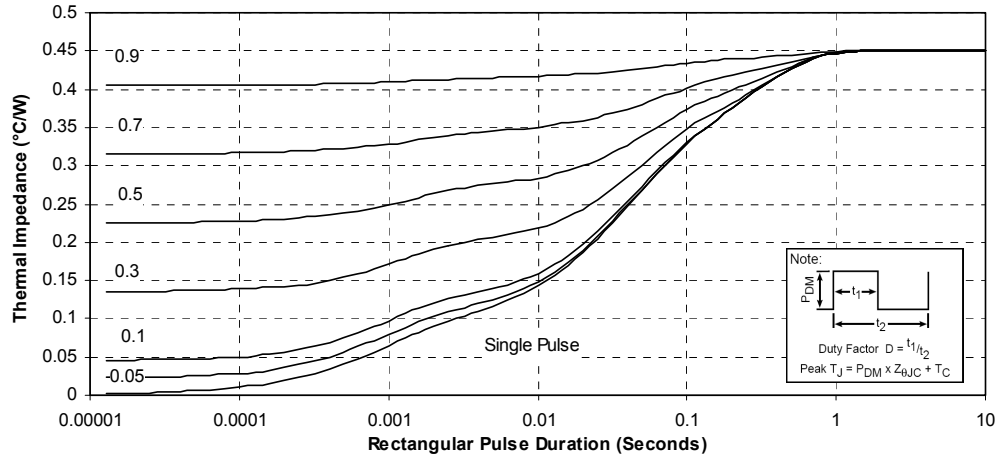



Figure 7, Maximum Effective Transient Thermal Impedance, Junction to Case vs Pulse Duration

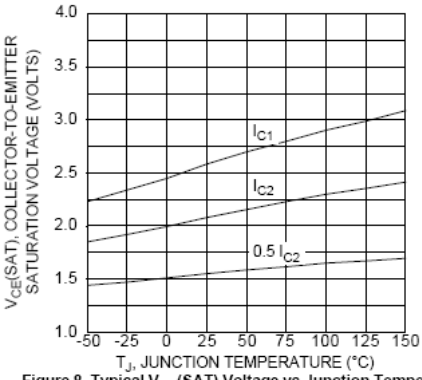



Figure 8, Typical $V_{CE}$(SAT) Voltage vs Junction Temperature

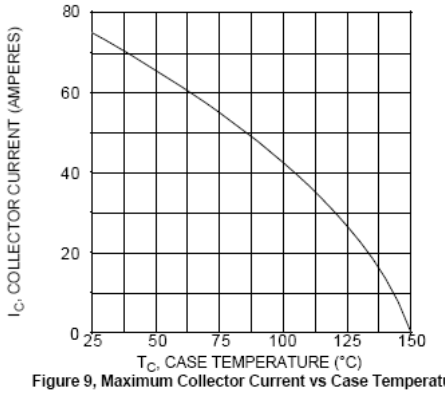



Figure 9, Maximum Collector Current vs Case Temperature

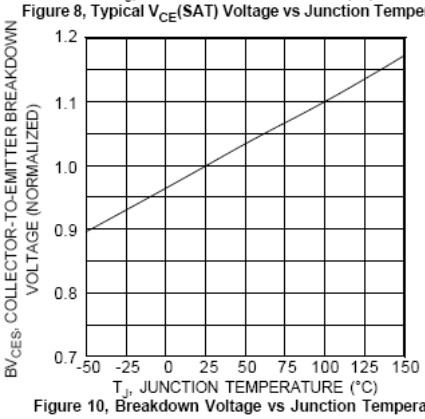



Figure 10, Breakdown Voltage vs Junction Temperature

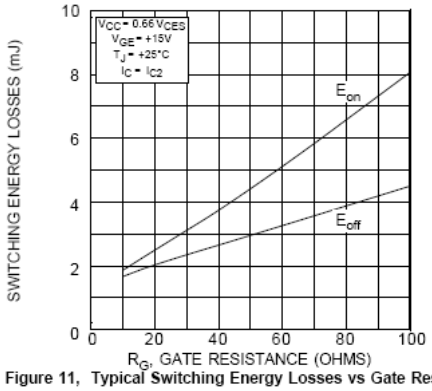



Figure 11, Typical Switching Energy Losses vs Gate Resistance

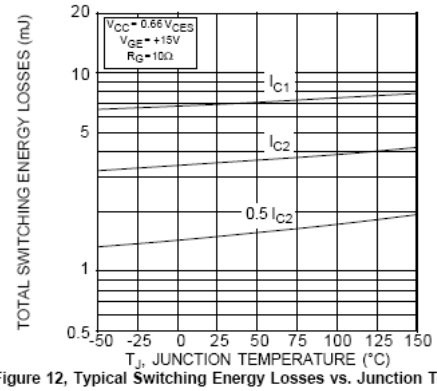



Figure 12, Typical Switching Energy Losses vs. Junction Temperature

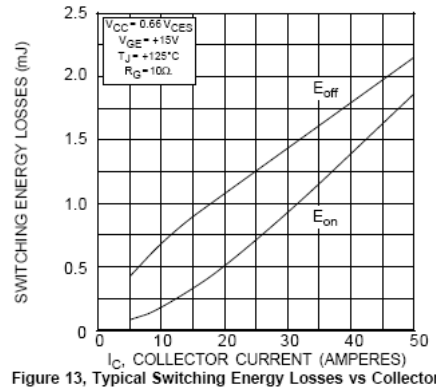



Figure 13, Typical Switching Energy Losses vs Collector Current

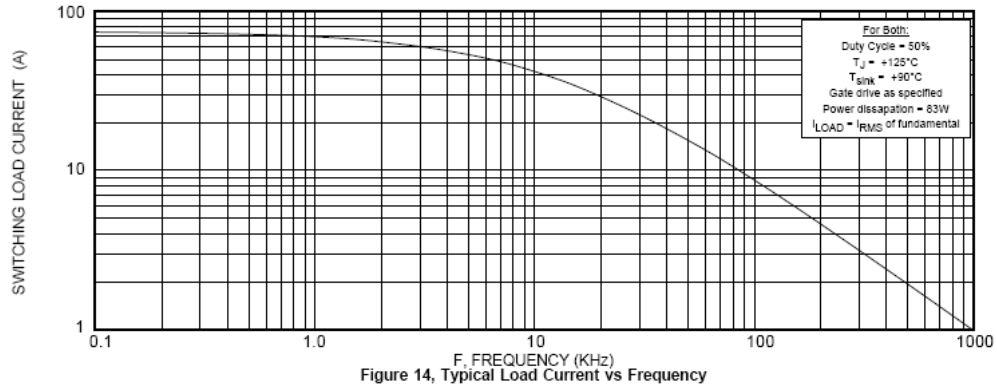



Figure 14, Typical Load Current vs Frequency

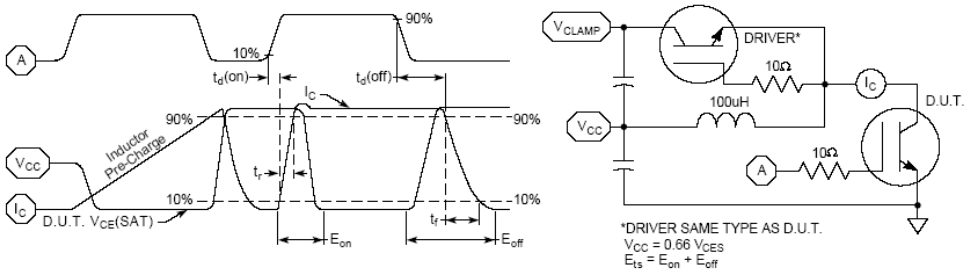



Figure 16, Switching Loss Test Circuit and Waveforms

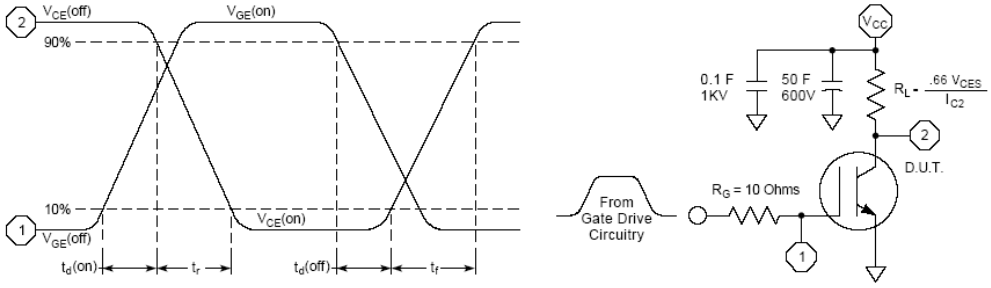



Figure 17, Resistive Switching Time Test Circuit and Waveforms

## Typical Diode Performance Curve

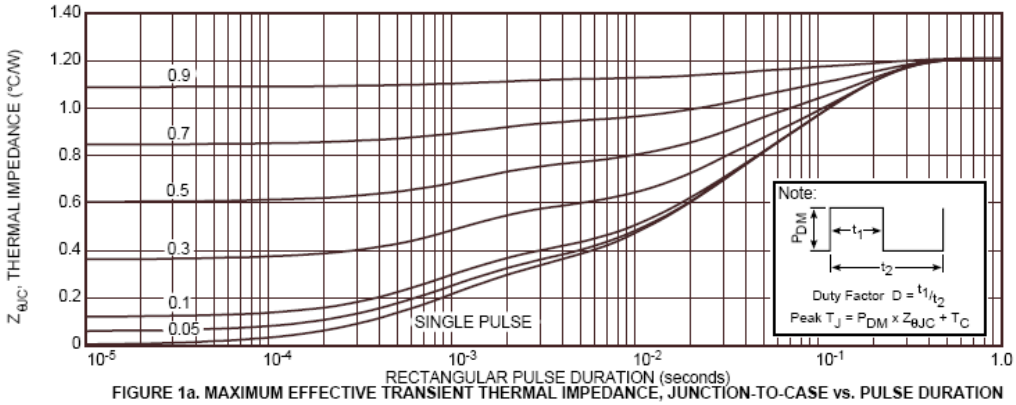



FIGURE 1a. MAXIMUM EFFECTIVE TRANSIENT THERMAL IMPEDANCE, JUNCTION-TO-CASE vs. PULSE DURATION

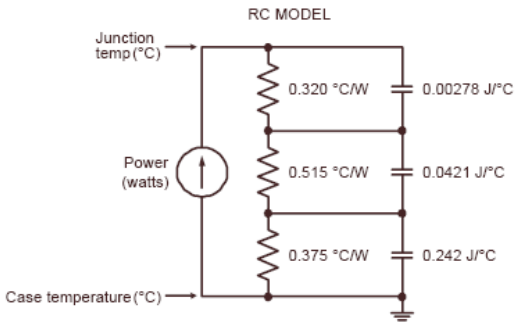



FIGURE 1b, TRANSIENT THERMAL IMPEDANCE MODEL

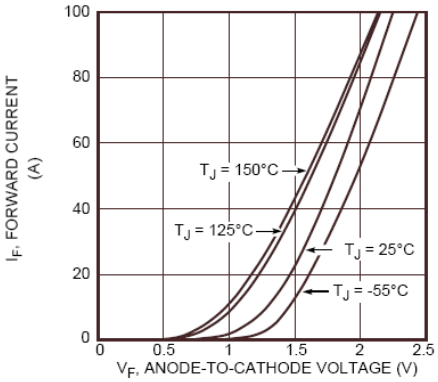



Figure 2. Forward Current *vs.* Forward Voltage

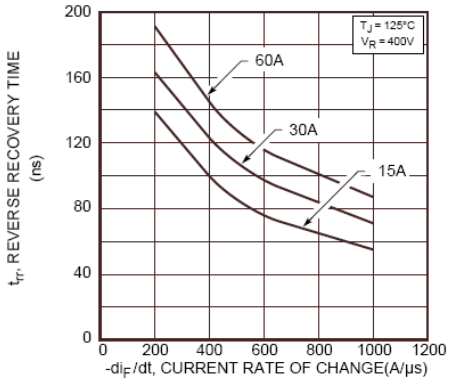



Figure 3. Reverse Recovery Time *vs.* Current Rate of Change

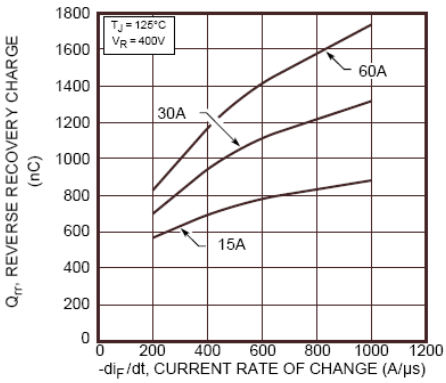



Figure 4. Reverse Recovery Charge *vs.* Current Rate of Change

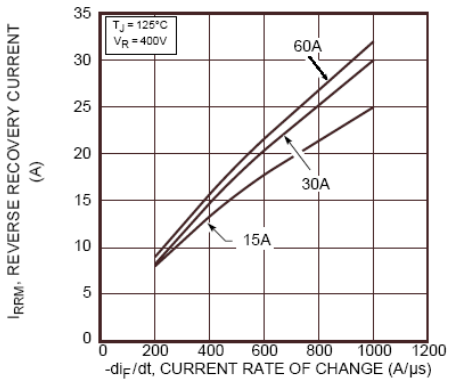



Figure 5. Reverse Recovery Current *vs.* Current Rate of Change

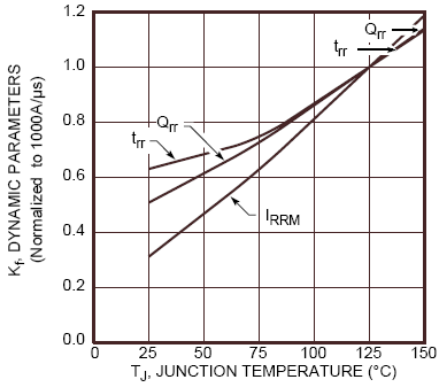



Figure 6. Dynamic Parameters *vs.* Junction Temperature

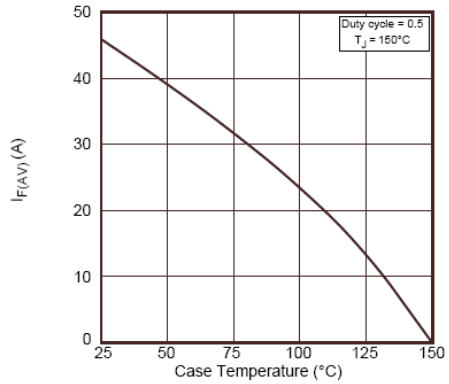



Figure 7. Maximum Average Forward Current *vs.* CaseTemperature

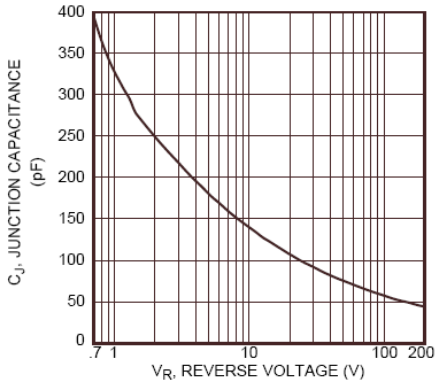



Figure 8. Junction Capacitance *vs.* Reverse Voltage

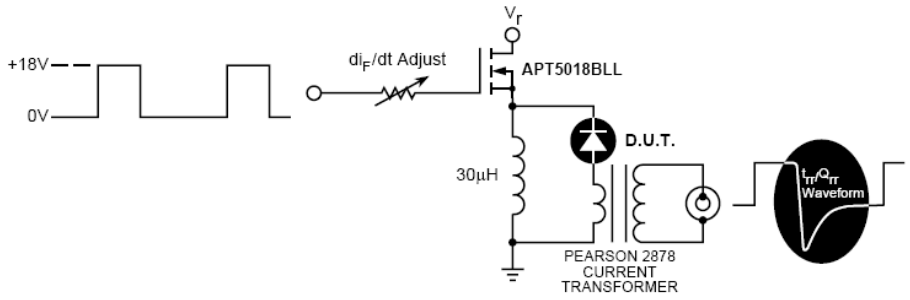



Figure 9. Diode Test Circuit

1. $I_F$ - Forward Conduction Current
2. $di_F/dt$ - Rate of Diode Current Change Through Zero Crossing.
3. $I_{RRM}$ - Maximum Reverse Recovery Current.
4. $t_{rr}$ - Reverse Recovery Time, measured from zero crossing where diode current goes from positive to negative, to the point at which the straight line through $I_{RRM}$ and $0.25 \bullet I_{RRM}$ passes through zero.
5. $Q_{rr}$ - Area Under the Curve Defined by $I_{RRM}$ and $t_{rr}$.

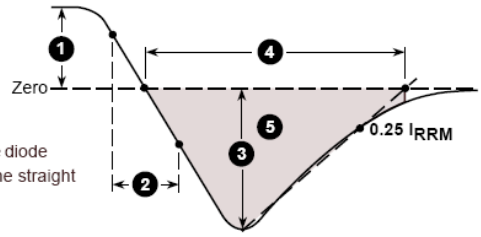
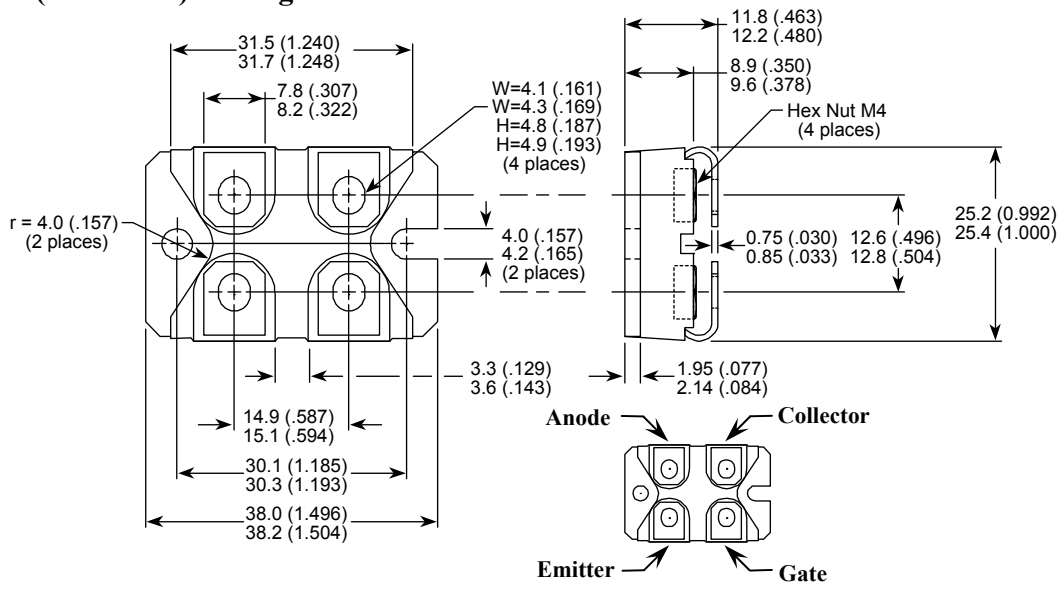



Figure 10, Diode Reverse Recovery Waveform and Definitions

## SOT-227 (ISOTOP®) Package Outline




Dimensions in Millimeters and (Inches)

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Buyer agrees not to use Products in any Life Support Applications and to the extent it does it shall conduct extensive testing of the Product in such applications and further agrees to indemnify and hold Seller, and its officers, employees, subsidiaries, affiliates, agents, sales representatives and distributors harmless against all claims, costs, damages and expenses, and attorneys' fees and costs arising, directly or directly, out of any claims of personal injury, death, damage or otherwise associated with the use of the goods in Life Support Applications, even if such claim includes allegations that Seller was negligent regarding the design or manufacture of the goods.

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